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(54) OPTICAL INFORMATION MEDIUM HAVING SEPARATE RECORDING LAYERS

OPTISCHES AUFZEICHNUNGSMEDIUM MIT VERSCHIEDENEN AUFZEICHNUNGSSCHICHTEN

SUPPORT OPTIQUE D'INFORMATIONS A COUCHES D'ENREGISTREMENT SEPAREES

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[0008] It is an object of the invention to provide an optical information medium of the kind described in the opening paragraph, in which an optimal recording and erasing behavior is achieved with a laser-light write pulse strategy which is substantially equal for the recording layers and a recording velocity which is substantially equal for the recording layers.

[0009] This object is achieved in that

- the first recording stack comprises a phase change type recording layer of a kind selected from a kind with substantially growth dominated crystallization and a kind with substantially nucleation dominated crystallization and
- the second recording stack comprises a phase change type recording layer of a kind different from the kind selected for the first recording stack.

[0010] The principle of the optical information medium of the invention can be schematically explained by e.g. the following layer structure:

$|IP_1|IS|IP_2|IM|$

wherein IP_1I is the first recording stack, IP_2I is the second recording stack, wherein I and S have the above-mentioned meaning. M is a metal mirror layer and P_1 and P_2 are phase change type recording layers of a different kind. During recording and reading the laser-light beam of an optical recorder is incident via the first recording stack. The substrate on which the layer structure is disposed can either be present adjacent the metal layer M, in which event the laser-light beam enters via the first recording stack without passing the substrate, or adjacent the first recording stack, in which event the laser-light beam enters via the first recording stack after passing the substrate layer. At the side of the layer structure, which is remote from the substrate, a cover layer may be present, which protects the layer structure from the environment.

[0011] The invention is based on the insight that the crystallization kinetics of the recording layers has to be matched with the thermal and/or optical properties of the layers adjacent the recording layers by the choice of material of the recording layer. Two mechanisms of crystallization are known: growth dominated and nucleation dominated crystallization. The presence of a metal mirror M causes the second recording stack to be a relatively fast cooling structure because M acts as a heat sink, whereas the first recording stack is a relatively slowly cooling structure because of the absence of a metal heat sink. In other words the cooling rate, which is important for quenching the amorphous phase during writing, and the recording sensitivity are different for the recording stacks. By choosing recording layers with substantially different crystallization properties this can be compensated for. Addition of at least one transparent, and therefore relatively thin, metal layer adjacent the first recording stack is possible. The heat sink capacity of such an additional metal layer is relatively low. Such a layer may therefore be used to fine-tune the optical reflection and to fine-tune the heat sink capacity of the first recording stack.

[0012] During DOW, the speed with which amorphous phase recording marks can be recrystallized determines the data rate, which is inversely proportional to the CET. Before a new mark can be written, the present mark has to be erased completely. Thus the speed with which erasure or recrystallization can take place limits the maximum data rate of the recording medium. The first recording stack is a relatively slowly cooling structure and the recording layer must be thin in order to have sufficient laser light transmitted to the second recording stack.

[0013] When the phase change material of the recording layer of the second recording stack has a nucleation dominated crystallization and has a relatively low CET, the choice of the phase change material of the recording layer of the first recording stack is a material with growth dominated crystallization, having a relatively low CET. Choosing a nucleation dominated crystallization phase change material would result in a relatively high CET because nucleation of crystallites is less likely to occur when a layer is thin.

[0014] When the second recording stack has a phase change recording layer material with growth dominated crystallization and a relatively large CET, it is advantageous to choose a thin crystallization nucleation dominated recording layer in the first recording stack in order to match the behavior of the recording layer in the second recording stack.

[0015] The dielectric layers preferably are of a mixture of ZnS and SiO_2, e.g. $(ZnS)_{80}(SiO_2)_{20}$. Alternatively the layers may be of SiO_2, Ta_2O_5, TiO2, ZnS, Si_3N_4, AlN, Al_2O_3, MgO, ZnO, SiC, including their non-stoichiometric compositions. Especially Si_3N_4, AlN,Al_2O_3, MgO, ZnO, SiC are preferred because of their good thermal conductivity.

[0016] For the metal mirror layer metals such as Al, Ti, Au, Ni, Cu, Ag, Rh, Pt, Pd, Ni, Co, Mn and Cr, and alloys of these metals, may be used. Examples of suitable alloys are AlTi, AlCr and AlTa. The thickness of this metal mirror layer is little critical, but preferably the transmission is practically zero for obtaining maximal reflection. In practice a layer of about 100 nm, which has an optical transmission of zero and which is easy to deposit, is frequently used.

[0017] In an embodiment the first recording stack comprises a phase change type recording layer of a kind selected from a kind with substantially growth dominated crystallization comprising a compound of Q, In, Sb and Te wherein Q is selected from the group of Ag and Ge, and a kind with substantially nucleation dominated crystallization comprising a compound of Ge, Sb and Te.

[0018] Useful as a recording layer with substantially growth dominated crystallization is a compound of Q, In, Sb and Te, wherein Q is selected from the group of Ag and Ge, and

cording layer of the first and the second recording stack.

[0030] The surface of the disc-shaped substrate on the side of the recording stacks preferably is provided with a servo track that can be scanned optically. This servo track often is a spiral-shaped groove and is formed in the substrate by means of a mould during injection molding or pressing. These grooves can be alternatively formed in a replication process in the synthetic resin of the transparent spacer layer, for example, a UV light-curable acrylate.

[0031] The metal mirror layer and the dielectric layers have been provided by vapor deposition or sputtering.

[0032] The phase change recording layer has been applied to the substrate by vacuum deposition, electron beam vacuum deposition, chemical vapor deposition, ion plating or sputtering.

[0033] The invention will be elucidated in greater detail by means of an exemplary embodiment and with reference to the accompanying drawing, in which Fig.1 shows a schematic cross-sectional view of the optical information medium in accordance with the invention. The dimensions are not drawn to scale.

Exemplary embodiment.

[0034] Fig.1 shows the layer structure of an optical information medium for rewritable recording by means of a laser-light beam 14 or 15. The medium comprises a substrate 1. On a side of the substrate a first recording stack 8, comprising a phase change type recording layer 10, is present. The recording layer 10 is sandwiched between two dielectric layers 9 and 11 which are, for example, made of $(ZnS)_{80}(SiO_2)_{20}$ with a thickness of e. g. 100 nm and 90 nm respectively.

[0035] A second recording stack 2 is present, comprising a phase change type recording layer 5, The recording layer 5 is sandwiched between two dielectric layers 4 and 6 which are, for example, made of $(ZnS)_{80}$ $(SiO_2)_{20}$ with a thickness of e.g. 25 nm and 95 nm respectively.

[0036] A transparent spacer layer 7 is interposed between the first recording stack 8 and the second recording stack 2, and has a thickness larger than the depth of focus of the laser-light beam 14 or 15. The transparent spacer layer 7 may e.g. be a UV-cured acrylate with a thickness of e.g. 50 μm.

[0037] A metal mirror layer 3, e.g. made of aluminium with a thickness of 100 nm, is present proximate the second recording stack 2 and at the side of the second recording stack opposite to the side of the transparent spacer layer 7. The first recording stack 8 comprises a phase change type recording layer 10 of a kind with substantially growth dominated crystallization or a kind with substantially nucleation dominated crystallization. In this embodiment the first recording stack 8 comprises a phase change type recording layer 10 of a kind with substantially nucleation dominated crystallization comprising a compound of Ge, Sb and Te. Suitable is e.g. the stoichiometric compound $Ge_2Sb_2Te_5$, with a thickness of e.g. 7 nm. The second recording stack 2 comprises a phase change type recording layer 5 of a kind different from the kind selected for the first recording stack 8. Suitable is e.g. the compound of Ge, In, Sb and Te with atomic composition $Ge_{1.9}In_{0.1}Sb_{68}Te_{30}$, with a thickness of 15 nm, with substantially growth dominated crystallization.

[0038] Substrate 1 is a polycarbonate disc-shaped substrate having a diameter of 120 mm and a thickness of 0.6 mm.

[0039] A cover layer 12, made of e.g. a UV cured resin Daicure SD645, with a thickness of 100 μm is present adjacent dielectric layer 11.

[0040] The initial crystalline state of the recording layers 5 and 10 is obtained by heating the as-deposited amorphous alloy with a focused laser beam in a recorder.

[0041] A laser-light beam 14 for recording, reproducing and erasing of information is focused onto recording layer 10 of the first recording stack 8, and enters the stack 8 via the cover layer 12. Laser-light beam 15 is focused onto recording layer 5 of the second recording stack 2.

[0042] The first recording stack has a transmission of about 67 % in the amorphous state and a transmission of about 47 % in the crystalline state. The first recording stack has a reflection of about 1.6 % in the amorphous state and a reflection of about 8.2 % in the crystalline state. The second recording stack has an effective reflection of about 0.9 % in the amorphous state and an effective reflection of about 8.5 % in the crystalline state. The word effective meaning as "seen" through the first recording stack. The stacks have good recording properties. The jitter is below 13% up to 4000 overwrite cycles.

[0043] The invention provides a rewritable phase change optical information medium, such as DVD-Rewritable or DVR, with at least two recording layers, disposed on a side of a substrate, and which recording layers require a substantially equal recording velocity and a substantially equal laser-light write pulse strategy.

Claims

1. An optical information medium for rewritable recording by means of a laser-light beam (14, 15), said medium comprising a substrate (1) having disposed on a side thereof:

   - a first recording stack (8) comprising a phase change type recording layer (10), sandwiched between two dielectric layers (9, 11),
   - a second recording stack (2) comprising a phase change type recording layer (5), sandwiched between two dielectric layers (4, 6),
   - a transparent spacer layer (7), interposed be-

3. Optisches Informationsmedium nach Anspruch 2, **dadurch gekennzeichnet, dass** die atomare Zusammensetzung der Verbindung aus Q, In, Sb und Te durch die Formel $Q_aIn_bSb_cTe_d$ definiert wird und $0 < a \leq 15$, $0 < b \leq 6$, $55 \leq c \leq 80$, $16 \leq d \leq 35$, $a + b + c + d = 100$ gilt.

4. Optisches Informationsmedium nach Anspruch 2, **dadurch gekennzeichnet, dass** die atomare Zusammensetzung der Verbindung aus Ge, Sb und Te durch eine Fläche in dem ternären Zusammensetzungsschema Ge-Sb-Te definiert wird, wobei diese Fläche eine viereckige Form hat, mit den Eckpunkten: Sb_3Te_7, Ge_2Te_3, Ge_3Te_2, und SbTe.

5. Optisches Informationsmedium nach Anspruch 4, **dadurch gekennzeichnet, dass** die atomare Zusammensetzung der Verbindung von Ge, Sb und Te durch die Formel $Ge_{50x}Sb_{40-40x}Te_{60-10x}$, und $0{,}166 \leq x \leq 0{,}444$ definiert wird.

6. Optisches Informationsmedium nach Anspruch 1, 2, 3, 4 oder 5, **dadurch gekennzeichnet, dass** die Phasenänderungsaufzeichnungsschicht (10) des ersten Aufzeichnungsstapels (8) eine Dicke zwischen 5 und 15 nm hat, und dass die Phasenänderungsaufzeichnungsschicht (5) des zweiten Aufzeichnungsstapels (2) eine Dicke zwischen 10 und 35 nm hat.

7. Optisches Informationsmedium nach Anspruch 1, **dadurch gekennzeichnet, dass** die transparente Spacerschicht (7) eine Dicke von zumindest 10 Mikrometern aufweist.

Revendications

1. Support optique d'information pour l'enregistrement réinscriptible au moyen d'un faisceau de lumière laser (14, 15), ledit support comprenant un substrat (1) ayant disposé sur un côté de celui-ci:

   - une première pile d'enregistrement (8) comprenant une couche d'enregistrement (10) du type de changement de phase qui est enfermée entre deux couches diélectriques (9, 11),
   - une seconde pile d'enregistrement (2) comprenant une couche d'enregistrement (5) du type de changement de phase qui est enfermée entre deux couches diélectriques (4, 6),
   - une couche d'espacement transparente (7) qui est interposée entre la première (8) et la seconde pile d'enregistrement (2) qui présente une épaisseur étant supérieure à la profondeur de focalisation du faisceau de lumière laser (14, 15), et
   - une couche à miroir métallique (3) présente à proximité de la seconde pile d'enregistrement (2) et à un côté de la seconde pile d'enregistrement (2) qui se situe à l'opposé de la couche d'espacement transparente (7),

   caractérisé en ce que

   - la première pile d'enregistrement (8) comprend une couche d'enregistrement (10) du type de changement de phase d'un genre qui est sélectionné à partir d'un genre avec une cristallisation sensiblement dominée par croissance et à partir d'un genre avec une cristallisation sensiblement dominée par nucléation et
   - la seconde pile d'enregistrement (2) comprend une couche d'enregistrement (5) du type de changement de phase d'un genre qui est différent du genre qui est sélectionné pour la première pile d'enregistrement (8).

2. Support optique d'information selon la revendication 1, **caractérisé en ce que** la première pile d'enregistrement (8) comprend une couche d'enregistrement (10) du type de changement de phase d'un genre qui est sélectionné à partir d'un genre avec une cristallisation sensiblement dominée par croissance comprenant un composé de Q, de In, de Sb et de Te où Q est sélectionné à partir du groupe de Ag et de Ge, et à partir d'un genre avec une cristallisation sensiblement dominée par nucléation comprenant un composé de Ge, de Sb et de Te.

3. Support optique d'information selon la revendication 2, **caractérisé en ce que** la composition atomique du composé de Q, de In, de Sb et de Te est définie par la formule $Q_aIN_bSb_cTe_d$ où $0 < a \leq 15$, $0 < b \leq 6$, $55 \leq c \leq 80$, $16 \leq d \leq 35$, $a+b+c+d=100$.

4. Support optique d'information selon la revendication 2, **caractérisé en ce que** la composition atomique du composé de Ge, de Sb et de Te est définie par une zone dans le schéma de composition ternaire Ge-Sb-Te, ladite zone étant de forme quadrangulaire ayant les sommets: Sb_3Te_7, Ge_2Te_3, Ge_3Te_2 et SbTe.

5. Support optique d'information selon la revendication 4, **caractérisé en ce que** la composition atomique du composé de Ge, de Sb et de Te est définie par la formule $Ge_{50x}Sb_{40-40x}Te_{60-10x}$, et $0{,}166 \leq x \leq 0{,}444$.

6. Support optique d'information selon la revendication 1, 2, 3, 4 ou 5, **caractérisé en ce que** la couche d'enregistrement (10) du type de changement de phase de la première pile d'enregistrement (8) présente une épaisseur dans la gamme comprise entre 5 nm et 15 nm et **en ce que** la couche d'enregistre-

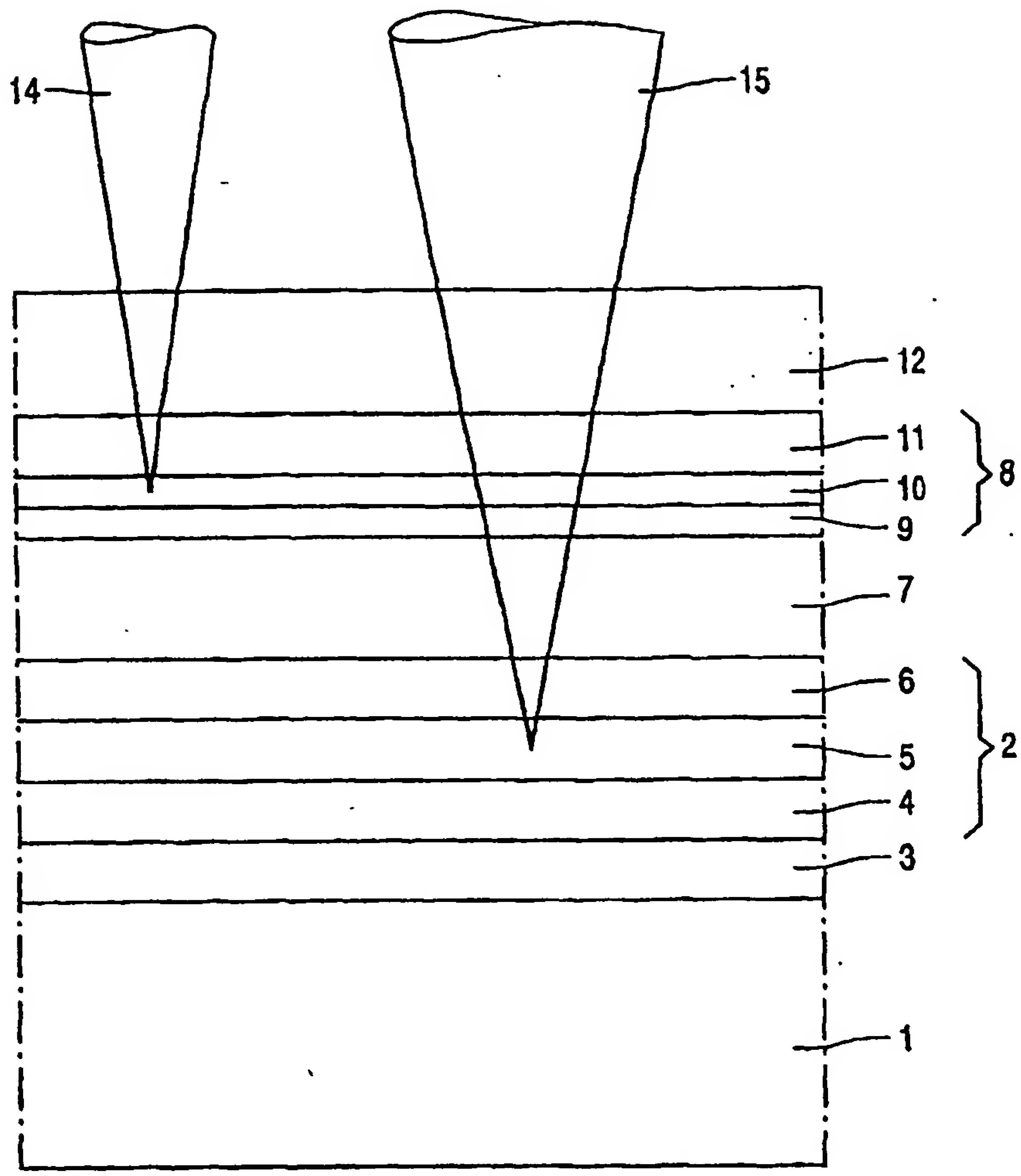

Fig. 1